GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF RESEARCH ADMINISTRATION

RESEARCH PROJECT INITIATION

Date: October 25, 1972

Project Title: Optimization of the Solvent Accelrated Fixation of Disperse Dyes on Polyester Fiber by Continuous Steaming

Project No: E-27-616

Principal Investigator Mr. Rick A. Porter

Sponsor: Textile Technology, Inc.

Agreement Period: From November 1, 1972 Until January 31, 1973

Type Agreement: Industrial Agreement dated October 11, 1972

Amount: $4,390.00

Reports Required: Final Technical upon completion

Sponsor Contact Person (s): Mr. C. Willard Ferguson
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Assigned to: Textile Engineering

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RA-3 (6-71)

GEORGIA INSTITUTE OF TECHNOLOGY

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RESEARCH PROJECT TERMINATION

Cert 2 A-214

Date: March 20, 1973

Project Title: Optimization of the Solvent Accelrated Fixation of Disperse Dyes on Polyester Fiber by Continuous Steaming

Project No: E-27-616

Principal Investigator: Mr. Rick A. Porter

Sponsor: Textile Technology, Inc.

Effective Termination Date: 3-20-73 (Final Report submitted)

Clearance of Accounting Charges: ASAP

Grant/Contract Closeout Actions Remaining: Final Invoice when all charges clear.

Assigned to: Textile Technology

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FINAL REPORT

Optimization of the Solvent Accelerated Fixation of Disperse Dye on Polyester Fiber by Continuous Steaming

A schematic diagram of the steamer used for this research is given in Figure 1. The speed of the steamer was reduced by 45/12 to give a retention time of 3.94 minutes at 5.63 fpm with a 0.9% extention between the nips. A side plate condenser was planned but it has not been constructed. It was to condense up to 26.4 cfm steam at 50 lb. gauge along with the perchloroethylene (perc) evaporated from the fabric. No estimate of recovery efficiency or side to side temperature gradient could be made without this condenser.

Dyeings were run in such a way that about ten feet of fabric received full exposure in the steamer while other portions were sampled through the side panel at 245, 83, 42, and 6 seconds exposure. These samples were analyzed for water and perc content by the Stark and Dean method and their color yield compared to a standard Thermosol formulation using 15% super clear and 1.5% Barisol BRM at 425° F for 90 seconds. A section of the fully treated material was taken to compare different methods of treatment after dyeing. The remaining portion of the fully treated material was evaluated visually for uniformity.

Six runs were made using the five dyes listed in Table 1. The steamer was initially filled with steam and the temperature stabilized. The temperature usually increased about 0.2° C during a run, perhaps due to increased stirring of the steam by the moving fabric. As runs were short, about 30 feet, a steady state perc vapor concentration was probably not obtained and the rate of evaporation would be slightly higher than to be expected in a long run. All pad baths were made up by dissolving 32 g of surfactant in

1280 ml perc. This solution was slowly poured into a blender containing 320 ml of water into which 5 g of the dye had previously been dispersed. When the volume became too large for the blender, a stirrer was used to add the rest of the perc and then this mixture was blended in smaller portions.

The surfactant used for the first runs was Tween 64 but the emulsion separated and later runs were made with G 2479. The emulsions produced were usually thin enough for use but when the viscosity was over ten centipoise extra water was added to obtain a lower viscosity. The perc was lost by the fabric quickly and it was noted that much of the dye was not fixed on the first five dyeings. The later dyeings were done with most of the pressure removed for the pad. Lose dye decreased, yield decreased and levelness noticeably improved. It was surprising that lower dye yield was obtained because the fiber remained in a swollen state for a longer period in the steamer.

The analytical results obtained from the six runs are given in Table 2. Considerable variation is to be expected in this data due to the methods of sampling and analysis. Even with this variation certain trends are indicated. First, a considerable amount of the dyeing occurs in the initial seconds of steaming. Second, dyeings using the low viscosity more stable emulsions give the more uniform rate of build and the more level results. Third, the perc loss and water gain is similar to that obtained in previous work. Table 3 details the uniformity and color yield relative to thermosol dyeings. Side to side and end to end uniformity was good but an unusual bar type unlevelness occurred in which outer portions of the wales were dark and inner portions were lightly colored. This may be due to wicking of the emulsion to the surface of the fabric as perc is evaporated. This bar type of nonuniformity along with blotches and resists were most noticeable in pastel shades and may limit the process to medium and dark shades. Specks occurred when crude dyes were used or if the dye was not dispersed properly before making the emulsion, but they were generally no difficulty. Spots both light and dark appear to be the major uniformity problem. Spots were of irregular shape usually about one inch in diameter. From the appearance and regularity light spots seem to be due to problems in preparation rather than drippage and would probably be much improved by solvent prescouring. For practical reasons the goods used were aqueous prescoured. The dark spots on the other hand appear to be due to emulsion breakdown as they can be eliminated by extensive blending.

After dyeing, samples about a square foot in size were given one of the following six treatments.

1) solvent rinse 70° C, steam
2) solvent rinse 70° C
3) solvent rinse 70° C, hydro clear, steam
4) solvent rinse 70° C, hydro clear
5) hydro clear, steam
6) hydro clear

The solvent rinse tended to produce a crack-marked appearance because the fabrics were folded in order to enter the entire sample into the beaker of solvent. Removal of surface dye was good and solvent rinse and steam <u>open width</u> should be an acceptable method of afterscour. For laboratory use a hydro clear and steam seem most acceptable.

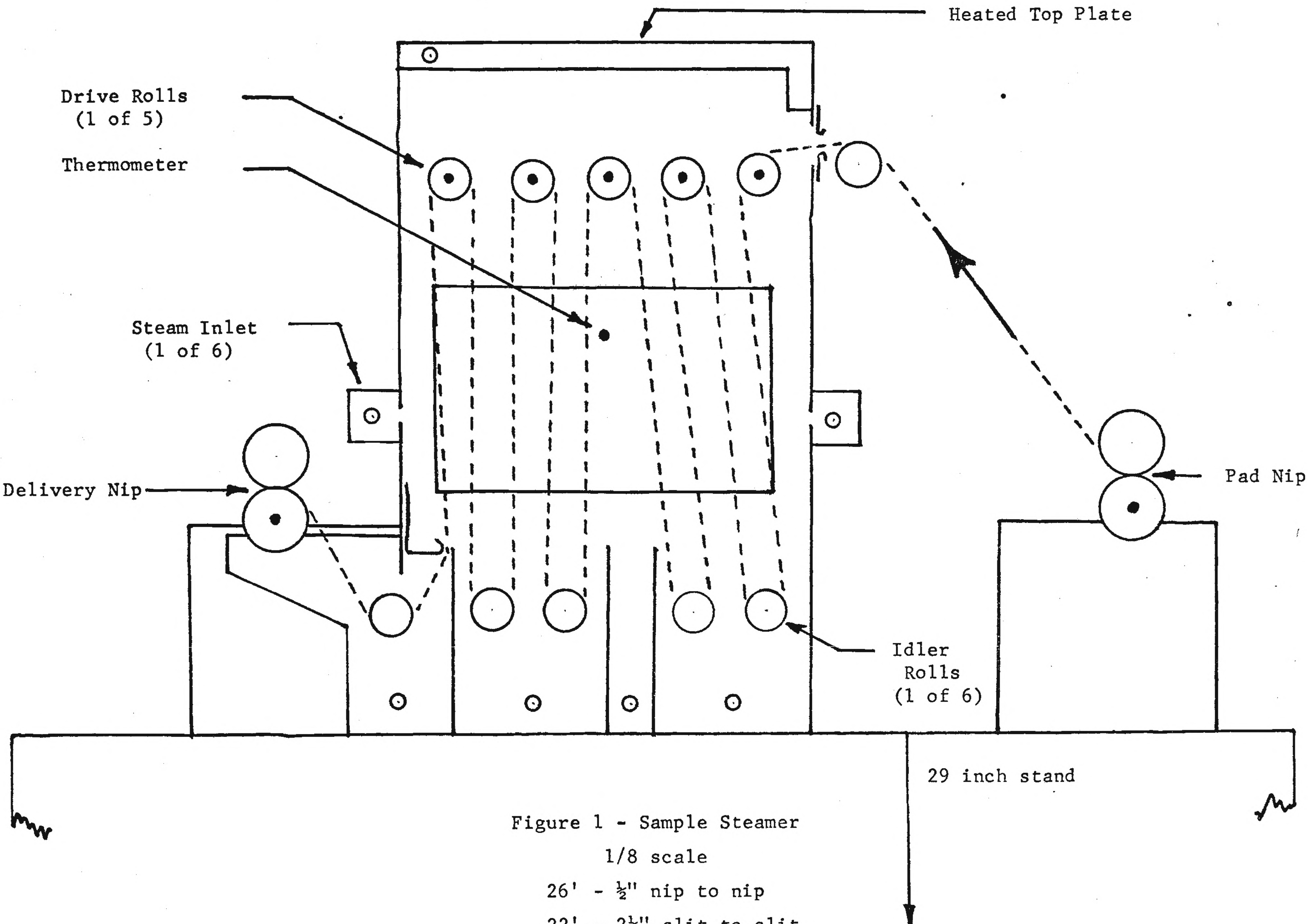

Figure 1 - Sample Steamer

1/8 scale

26' - ½" nip to nip

22' - 2½" slit to slit

TABLE 1

Conditions of Steamer Runs

Run	Dye	Surfactant	Emulsified Water(ml)	Average Temp.(°C)	Viscosity Centipoise	Pickup
1	Eastman F. Yellow 4RLF	Tween 64	320	97.75	9.0	.719
2	Foron Yellow SESCW	Tween 64	380	98.95	9.6	1.432
3	Latyl Yellow 3G	Tween 64	320	98.85	2.4	1.298
4	Artisil Yellow G	Tween 64	320	98.40	2.4	1.554
5	Artisil Yellow GLF	G 2479	320	98.80	2.3	1.311
6	Eastman F. Yellow 4RLF	G 2479	320	99.20	2.3	3.510

TABLE 2

Analytical Results of Steamer Runs

Run	Steaming time (sec) 6			42			83			245		
	% water	% perc	K/S λmax	% water	% perc	K/S λmax	% water	% perc	K/S λmax	% water	% perc	K/S λmax
1	24	2	.549	24	.1	.480	50	.1	.384	25	0	.648
2	24	2	.572	24	.2	.555	70	.3	.648	21	0	.509
3	30	2	2.54	36	.4	3.56	44	.0	3.52	24	0	3.33
4	23	2	.811	19	.5	.858	26	.1	1.04	22	0	1.06
5	23	2	.259	25	.3	.369	27	.0	.524	19	0	.589
6	36	8	1.29	41	1.2	1.40	41	.7	1.58	40	0	1.60

TABLE 3

Uniformity and Color Yield

Run	Realitive Yield Etherm/Esolvent	Uniformity in spots per foot Dark	Light
1	.93	1.9	7
2	3.07	0	0
3	1.13	0	5
4	3.86	.3	1
5	2.07	.5	12
6	1.83	0	0

Relative yield was obtained as follows

$$\frac{E_1}{E_2} = \frac{K_1 S_2 P_2}{K_2 S_1 P_1}$$

where Si = dye in pad mix
Pi = pickup of pad mix
Ki = K/S after dyeing at λ max
Ei = fixation efficiency or yield

i = 1 thermosol dyeing
i = 2 solvent steaming dyeing

using consistent units